REPORT ON NASA GRANT NsG-120 TO THE UNIVERSITY OF ARIZONA

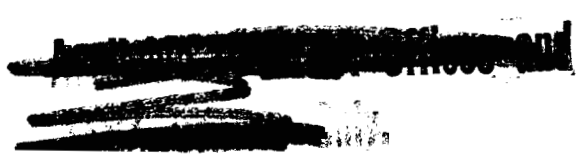
This is the semiannual status report of work done during the period from August 1, 1965 through January 31, 1966 under National Aeronautics and Space Administration Grant NsG-120 to study the production, detection and properties of soft x-rays.

Work carried out during the last half year, in extension of that described in the last report, deals on the one hand with wave lengths up to ca 80A., and on the other with attempts to measure still longer radiations. Our current objectives are different for the two spectral regions.

As previously indicated, many of the chemical elements giving L and M spectra in the shorter of these two regions are too light to have electrons in the energy levels involved in producing their strongest (α, β and γ) lines. Their spectra, as we observe them, therefore consist only of lines which ordinarily are rated as weak. We are mapping this progressive simplification of x-ray spectrum as function of atomic number. Some of the spectral lines in the region under consideration are due to the electrons that are involved in chemical combination; they are consequently influenced by the valency state of the responsible atoms. This valency effect is manifested in

small shifts in wave length and, where electrons in conduction bands are involved, by changes in line shape. Line intensities also are affected though this fact has received little attention thus far because the requisite intensity data have not been available. In preceding reports we have provided results of preliminary intensity measurements of many of the L and M spectra lying in the region under study. These have now been extended to include several chemical elements not previously available, and we have been seeking to improve the accuracy with which intensities can be measured. We have also begun evaluating factors, such as reflecting crystal and sample absorption, which must be taken into account before the absolute intensities that relate directly to valence can be calculated. Depending on the wave lengths being studied, different types of excitation are being employed - fluorescent, direct electron bombardment and the mixed excitation obtained with windowless x-ray tubes. Such intensity measurements in the region shorter than 80A. will form a continuing part of our program and we plan to publish better and more complete data as they become available.

Over the last half year, however, we have begun to give major attention to the examination of longer wave lengths. This is proceeding in the following three directions: (1) the search for new means of producing very long x-rays, (2) the search for a satisfactory detector in place of the proportional gas counter used for shorter radiations and (3) an improvement in our ruled



grating vacuum spectrometer.

(1) The paucity of lines in the long wave length L and M spectra makes it apparent that other than x-ray tubes must be used as sources for radiations longer than ca 100A. We accordingly are devoting an increasing amount of time to experiments with gas discharges which might reasonably be expected to yield radiation in the very soft x-ray region and to problems of vacuum technique which such gaseous sources introduce. This development is proceeding steadily, but slowly because of the large amount of shop construction it entails.

(2) Though we shall be able to extend our observations somewhat beyond ca 80A.,by employing a proportional counter having an ultrathin window and gas at reduced pressures, the need to avoid any window when dealing with much longer radiations calls for a photoelectric detector of some sort. In spite of the comparatively low sensitivity obtained with the Bendix type counter in our experiments with wave lengths shorter than 100A,, we are resuming work with it in the hope that in combination with a sufficiently intense source it can be used satisfactorily for very long x-rays.

(3) Though we have had no difficulty in measuring with our present ruled grating spectrometer the relatively weak lines that remain in L and M spectra of wave lengths of ca 80A., it has seemed important to build apparatus that will

measure the longer wave lengths more conveniently and with greater accuracy. We have therefore constructed a larger vacuum chamber of stainless steel pumped with our molecular pumping system. This is currently functioning routinely in the 10^{-8} to 10^{-9} mm. range without bake-out, and is being used in a series of studies designed to improve the performance of our Bendix photomultiplier. It is planned ultimately to rebuild certain parts of the existing ruled grating spectrometer in the light of experience already gained with it and then to install it in the large chamber. In this way better pre-alignment procedures can be carried out, we will have more latitude in making experiments with different sources and spectral photographs can be taken as controls on the measurements of intensity.

The only publication under this Grant during the last six months is:

Franklin D. Davidson and Ralph W.G. Wyckoff, "L and M X-Ray Spectra in the Region from 2 - 85A," which is appearing in Volume 9 of "Advances in X-Ray Analysis." Reprints will be forwarded when received.